Public Citizen

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Joan Claybrook, President

November 9, 2000

Dockets Management Branch
HFA-305
Food and Drug Administration
5630 Fishers Lane — Room 1061
Rockville, MD 20852

Re: Docket No. 99F-2673 — "Irradiation in the Production, Processing and Handling of Food"

To whom it may concern:

Under the provisions of 21 CFR §12.24, Public Citizen is requesting a formal evidentiary public hearing for the purposes of revoking the Food and Drug Administration's ruling on Docket No. 99F-2673 — "Irradiation in the Production, Processing and Handling of Food" (65 FR 64605).

We have identified and seek to present at a public hearing genuine and substantial issues containing evidence that raises material issues of fact and questions in a material way the rationale of this ruling.

(1) In its ruling, the FDA did not establish a "safety factor in applying animal experimentation data to man of 100 to 1 ... that is, a food additive for use by man will not be granted a tolerance that will exceed 1/100th of the maximum amount demonstrated to be without harm to experimental animals," as required by 21 CFR §170.22. Public Citizen is requesting a formal evidentiary public hearing on this matter.

(2) In its ruling, the FDA did not follow the "principles and procedures for establishing the safety of food additives stated in current publications of the National Academy of Sciences-National Research Council," as required by 21 CFR §170.20. Public Citizen is requesting a formal evidentiary public hearing on this matter.

(3) The petitioner, Caudill Seed Co. Inc., submitted "[n]o conventional animal toxicity studies on sprouts from irradiated seeds," according to a Feb. 28, 2000, memorandum from Isabel S. Chen (Scientific Support Branch) to Joann Ziyad (Regulatory Policy Branch). To support the conclusion that "we do not expect any deleterious effects from consuming sprouts from irradiated seeds," Chen referenced two book chapters, one review article, and unspecified studies that do not address the potential toxicity of irradiated sprouts. Public Citizen is requesting a formal evidentiary public hearing on this matter.

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99F-2673 C 2

Ralph Nader, Founder
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(4) In a Feb. 23, 2000, memorandum from Kim M. Morehouse (Division of Product Manufacture and Use) to Ziyad, Morehouse states that "radiolysis products which may have been formed by irradiation of the seeds will be 'diluted' in the final product. ... Also, it is likely that water-soluble products will be removed by the growth medium." To support these conclusions, Morehouse referenced no data of any kind. Public Citizen is requesting a formal evidentiary public hearing on this matter.

(5) In its Federal Register filing, the FDA stated that the "petitioner submitted published articles and other study reports containing data and information related to seeds for sprouting ... in the areas of radiation chemistry [and] toxicity." This statement is incorrect. Regarding toxicity, the memorandum referenced in (3) above clearly states otherwise; regarding radiation chemistry, the memorandum referenced in (4) makes no mention of such information. Public Citizen is requesting a formal evidentiary public hearing on this matter.

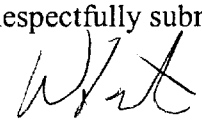
(6) In its Federal Register filing, the FDA stated that the agency "concluded that the concentrations and types of radiolysis products formed by the irradiation of seeds for sprouting will be comparable to those products produced by the irradiation of foods of similar composition. Most of these radiolysis products are formed in very small amounts and are either the same as, or structurally similar to, compounds found in foods that have not been irradiated. Thus, the chemical compositions of sprouts grown from irradiated seeds will not differ in any significant manner from sprouts grown from seeds that have not been irradiated." This statement is unsubstantiated. The memoranda referenced in (3) and (4) above include no such analyses of the radiolysis products in irradiated sprouting seeds. Public Citizen is requesting a formal evidentiary public hearing on this matter.

(7) The petitioner, Caudill Seed Co. Inc., "submitted very crude data regarding the nutritive value (including protein, fiber, ash, carbohydrates, fat, total vitamin A, vitamin A/retinol, beta carotene and vitamin C) of sprouts from 6 kGy irradiated seeds and non-irradiated seeds (as controls)," according to the Feb. 23 memorandum from Chen to Ziyad. The data, Chen wrote, was generated by researchers who "did not specify what kind of sprouts were analyzed" and "did not specify the sources of the sprouts or the number of samples which were analyzed." Chen also wrote that the petitioner "did not supply any explanation as to why the results were different" between the two laboratories where the studies were conducted. Public Citizen is requesting a formal evidentiary public hearing on this matter.

(8) In its ruling, the FDA approved the irradiation of sprouting seeds at a maximum dose of 8 kiloGray, though data were submitted on the nutritional changes in sprouting seeds irradiated at only 6 kiloGray. Public Citizen is requesting a formal evidentiary public hearing on this matter.

Taken together, these flaws in the FDA's ruling represent genuine and substantial issues containing evidence that raises material issues of fact and questions in a material way the rationale of the ruling. We request that a formal evidentiary public hearing be held at the earliest possible date.

Respectfully submitted,



Wenonah Hauter
Director
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any residue from the raw agricultural commodity in the processing (such as by peeling or washing) and so long as the concentration of the residue in the processed food when ready to eat is not greater than the tolerance prescribed for the raw agricultural commodity. But when the concentration of residue in the processed food when ready to eat is higher than the tolerance prescribed for the raw agricultural commodity, the processed food is adulterated unless the higher concentration is permitted by a tolerance obtained under section 409 of the Act. For example, if fruit bearing a residue of 7 parts per million of DDT permitted on the raw agricultural commodity is dried and a residue in excess of 7 parts per million of DDT results on the dried fruit, the dehydrated fruit is adulterated unless the higher tolerance for DDT is authorized by the regulations in this part. Food that is itself ready to eat, and which contains a higher residue than allowed for the raw agricultural commodity, may not be legalized by blending or mixing with other foods to reduce the residue in the mixed food below the tolerance prescribed for the raw agricultural commodity.

Subpart B—Food Additive Safety

§ 170.20 General principles for evaluating the safety of food additives.

(a) In reaching a decision on any petition filed under section 409 of the Act, the Commissioner will give full consideration to the specific biological properties of the compound and the adequacy of the methods employed to demonstrate safety for the proposed use, and the Commissioner will be guided by the principles and procedures for establishing the safety of food additives stated in current publications of the National Academy of Sciences-National Research Council. A petition will not be denied, however, by reason of the petitioner's having followed procedures other than those outlined in the publications of the National Academy of Sciences-National Research Council if, from available evidence, the Commissioner finds that the procedures used give results as reliable as, or more reliable than, those reasonably to be expected from the use of the outlined procedures. In reaching a decision, the Commissioner will give due weight to the anticipated levels and patterns of consumption of the additive specified or reasonably inferrable. For the purposes of this section, the principles for evaluating safety of additives set forth in the abovementioned publications will apply to any substance that may properly be classified as a food additive as defined in section 201(s) of the Act.

(b) Upon written request describing the proposed use of an additive and the proposed experiments to determine its safety, the Commissioner will advise a person who wishes to establish the safety of a food additive whether he believes the experiments planned will yield data adequate for an evaluation of the safety of the additive.

§ 170.22 Safety factors to be considered.

In accordance with section 409(c)(5)(C) of the Act, the following safety factors will be applied in determining whether the proposed use of a food additive will be safe: Except where evidence is submitted which justifies use of a different safety factor, a safety factor in applying animal experimentation data to man of 100 to 1, will be used; that is, a food additive for use by man will not be granted a tolerance that will exceed 1/100th of the maximum amount demonstrated to be without harm to experimental animals.

§ 170.30 Eligibility for classification as generally recognized as safe (GRAS).

(a) General recognition of safety may be based only on the views of experts qualified by scientific training and experience to evaluate the safety of substances directly or indirectly added to food. The basis of such views may be either (1) scientific procedures or (2) in the case of a substance used in food prior to January 1, 1958, through experience based on common use in food. General recognition of safety requires common knowledge about the substance throughout the scientific community knowledgeable about the safety of substances directly or indirectly added to food.

SUBCHAPTER B—FOOD FOR HUMAN CONSUMPTION

PART 170—FOOD ADDITIVES

Subpart A—General Provisions

Subpart B—Food Additive Safety

Subpart C—Specific Administrative Rulings and Decisions

AUTHORITY: 21 U.S.C. 321, 341, 342, 346a, 348, 371.

SOURCE: 42 FR 14483, Mar. 15, 1977, unless otherwise noted.

Subpart A—General Provisions

§ 170.3 Definitions.

For the purposes of this subchapter, the following definitions apply:

(a) *Secretary* means the Secretary of Health and Human Services.

(b) *Department* means the Department of Health and Human Services.

(c) *Commissioner* means the Commissioner of Food and Drugs.

(d) As used in this part, the term *act* means the Federal Food, Drug, and Cosmetic Act approved June 25, 1936, 52 Stat. 1040 *et seq.*, as amended (21 U.S.C. 301–392).

(e)(1) *Food additives* includes all substances not exempted by section 201(s) of the act, the intended use of which results or may reasonably be expected to result, directly or indirectly, either in their becoming a component of food or otherwise affecting the characteristics of food. A material used in the production of containers and packages is subject to the definition if it may reasonably be expected to become a component, or to affect the characteristics, directly or indirectly, of food packed in the container. "Affecting the characteristics of food" does not include such physical effects, as protecting contents of packages, preserving shape, and preventing moisture loss. If there is no migration of a packaging component from the package to the food, it does not become a component of the food and thus is not a food additive. A substance that does not become a component of food, but that is used, for example, in preparing an ingredient of the food to give a different flavor, texture, or other characteristic in the food, may be a food additive.

(2) *Uses of food additives not requiring a listing regulation.* Substances used in food-contact articles (e.g., food-packaging and food-processing equipment) that migrate, or may be expected to migrate, into food at such negligible levels that they have been exempted from regulation as food additives under § 170.39.

(f) *Common use in food* means a substantial history of consumption of a substance for food use by a significant number of consumers.

(g) The word *substance* in the definition of the term "food additive" includes a food or food component consisting of one or more ingredients.

(h) *Scientific procedures* include those human, animal, analytical, and other scientific studies, whether published or unpublished, appropriate to establish the safety of a substance.

(i) *Safe* or *safety* means that there is a reasonable certainty in the minds of

Memorandum

Date February 28, 2000

AD

From SCIENTIFIC SUPPORT BRANCH (HFS-207)

Subject Use of Irradiation to Control Microbial Pathogens in Alfalfa and Other Sprouting Seeds

To REGULATORY POLICY BRANCH (HFS-206)

ATTENTION: Joann Ziyad, Ph.D.

FAP 9M4673

Caudill Seed Company Inc.
1402, West Main Street,
Louisville, KY 40203

Caudill Seed Company Inc. has submitted a petition requesting that 21 CFR part 179 of the food additive regulations be amended to allow the use of approved sources of ionizing radiation including ^{60}Co, ^{137}Cs and X-rays, as a physical process for the treatment of alfalfa and other sprouting seeds. This petition (FAP 9M4673) incorporates by reference information in an earlier, incomplete submission (FAP 9M4651) from the same company. The petitioner indicated that the presence of a few pathogen cells on the seeds can be amplified by the sprouting process, which generates a health hazard. The petitioner gave many examples of outbreaks of illness caused by *Salmonella enterica serotype newport, Salmonella stanley, Salmonella saint-paul* and *Escerichia coli* 0157:H7 in Europe (United Kingdom, Finland, Sweden etc.), the United States, and Japan because of consumption of uncooked alfalfa and/or other sprouts.

The stated purpose of this petition is to apply ionizing radiation to sprouting seeds to control or reduce the number of *Salmonella* or *E. coli* organisms. Thus, the incidence of food-borne illness from these microbial pathogens will be reduced. The radiation dose range requested in the petition is from 1 to 8 kGy. The petitioner indicates that dosage levels up to 6 kGy have been shown to satisfactorily reduce the pathogen levels in the sprouts. However, in some instances the seeds may contain much higher levels of bacteria; thus, higher dosage levels (up to 8 kGy) may be required to treat the seeds for sprouts. The microbiological issues will be discussed by another reviewer in a separate memorandum; this memorandum reviews toxicological and nutritional considerations regarding sprouts from irradiated alfalfa and other sprouting seeds.

Dietary Exposure Estimates of Sprouts

Generally, estimates of human dietary exposure to a compound and/or a food are presented as "estimated daily intakes" (EDIs), which is a life-time averaged "chronic" estimate of intake by the consumer. Sprouts, however, are an infrequently consumed food with the result that estimated intake is best considered on a per eating-occasion basis (an acute exposure). Based on the United States Department of Agriculture's continuing surveys (3-day survey) of food intake by individuals (15,000 participants) from 1989 to 1991, less than 1% of the respondents to the survey reported eating sprouts. In a more recent survey (2-day survey from 1994 to 1996), more than 2.5% out of 15,000 participants who responded reported eating-occasions. Usually, the big sprouts (mung bean) are eaten cooked and small sprouts (alfalfa) are eaten raw; the dietary exposure estimates for raw (alfalfa) and cooked (mung bean) sprouts are listed in Table 1. The dietary exposure to the sprouts is reported as grams consumed per person per eating occasion (The Chemistry Review Team, DiNovi presentation to FDA Public Meeting dated September, 1998).

Table 1. Estimates of Dietary Exposure to Sprouts.

	Mean	90th Percentile
Adult	(grams/person)	(grams/person)
Raw Sprouts	38	85
Cooked Sprouts	44	95
Child (7 to 12 years old)		
Mung Bean Sprouts	41	64

The issue of radiolysis products that may be formed in the sprouts produced by irradiating alfalfa and other seeds has been assessed by Morehouse from the Division of Product Manufacture and Use (HFS-245, Morehouse memo of 2/23/00). He has concluded that the concentrations and types of radiolysis products formed by the irradiation treatment of seeds will be similar to that for other irradiated food. Most of radiolysis products are either the same as, or structurally similar to, compounds found in foods have not been irradiated.

Toxicological Safety Information of Irradiated Sprouts

No conventional animal toxicity feeding studies on sprouts from irradiated seeds were submitted in the petition. The petitioner submitted published references and study reports containing data and information related to irradiated foods in the areas of radiation chemistry, toxicology, nutrition and microbiology.

The petitioner's justification for the toxicological safety evaluation of sprouts from irradiated seeds is based on international reports and review articles. We have reviewed the relevant information/articles in the petition (see Attachment 1 Table) as follows:

1. A book chapter entitled "Radiological and Toxicological Safety of Irradiated Foods" in Safety of Irradiated Foods (Diehl, 1995).
With respect to toxicological safety, this book chapter discusses the history and the progression of the safety studies conducted to date, including animal feeding studies, in vitro tests, and chemical investigations on various irradiated foods. It also discusses in a general fashion, the uncertainties and problems of extrapolating results from animal studies to humans, particularly in "sensitive populations", such as pregnant women, babies, and the sick and elderly.

The author indicated that the most extensive critical overview of animal studies on irradiated food is the 1994 WHO Report (Safety and Nutritional Adequacy of Irradiated Food). A variety of irradiated foods including red meat, chicken, fish, fruit, grains, vegetables, etc. as well as whole diet were tested in the earlier animal feeding toxicity studies, nutritional studies, and genotoxicity studies. All long-term rat feeding studies with irradiated foods were listed in a Table in the chapter (page 180 to 183). We had already commented on this report in the conclusion of our previous memorandum (see FAP 8M4584, Chen memo of 12/11/98).

2. A book chapter entitled "Wholesomeness and Safety of Irradiated Foods"in Nutritional and Toxicological Consequences of Food Processing (Swallow, 1991).
Irradiation with gamma rays, X-rays or fast electrons can be used to destroy harmful organisms. However, food should be in good quality before it is irradiated and it should be kept under proper conditions after irradiation. The author concludes that if precautions are taken with respect to proper handling and the irradiation process is properly carried out on appropriate foods, irradiated foods are wholesome and safe.

3. An article entitled "Wholesomeness of Irradiated Foods" (Thayer,1994).
This review article indicated that in general, if proper food processing conditions were applied, no adverse products formed were noted in the irradiated food. The proper conditions include: appropriated radiation dose, dose rate, temperature and atmosphere during irradiation, and appropriate storage duration, temperature and atmosphere after irradiation. This article reviews the data cited by the FDA in support of the approval of irradiation of poultry meat at 1.5 to 3.0 kGy to control foodborne pathogens.

These submitted references summarize the animal and human studies conducted on a variety of irradiated food. Most essentially discuss studies from the same data base

created by the Agency's toxicologists, and considered in previous evaluations. In a previous memorandum, OPA noted that the study designs and parameters measured varied in these food irradiation studies. In some cases, the research was designed to test several different irradiated foods simultaneously. In the evaluation of individual studies by different FDA reviewers, some of the earlier individual study reports cannot stand alone to provide definitive answers; however, taken together as a whole, these studies present a consist finding of no harm when irradiated foods were tested in animal feeding studies and genetic toxicity studies (see FAP 4M4428, OPA, Hattan memo of 11/20/97).

In summary, although no conventional toxicity studies were submitted on the sprouts grown from irradiated seeds in this petition, based on the exposure estimate to the sprouts, and the amount of radiolysis products expected to be formed in the sprouts from irradiated seeds, and the Agency database of studies we do not expect any deleterious effects from consuming sprouts from irradiated seeds.

Nutrition Consideration of Sprouts from Irradiated Seeds

The petitioner submitted very crude data regarding the nutritive value (including protein, fiber, ash, carbohydrates, fat, total vitamin A, vitamin A/retinol, beta carotene and vitamin C) of sprouts from 6 kGy irradiated seeds and non-irradiated seeds (as controls) in FAP 9M4651, appendix C (see Attachment 2). The nutritive values of sprouts from irradiated seeds and non-irradiated seeds were analyzed by two independent laboratories but they did not specify what kind of sprouts were analyzed. The petitioner did not supply any explanation as to why the results were different between these two laboratories for the controls (unirradiated seed sprouts) and the irradiated seed sprouts. It did not specify the sources of the sprouts or the number of samples which were analyzed in each laboratory. Based on these two laboratories' data, the petitioner concluded that the nutritive value of sprouts from irradiated seeds was not reduced.

Published references on the nutritional impact of irradiation on food are listed with comments in the Table of Attachment 1. It is well documented that protein, fat and minerals are not significantly altered by irradiation at doses within the energy ranged in this petition. As for the irradiation sensitive vitamins, there were no data to compare sprouts grown from irradiated seeds to unirradiated seeds other than vitamin A and C values in Attachment 2. We provide some nutrition information on vitamin A, C, B_1, B_2, niacin, etc. of two commonly consumed vegetables as well as mung bean sprouts for reference in Table 2. Since sprouts are infrequently consumed and they are not considered a major dietary constituent, one can conclude that bean sprouts do add nutritive value to the human diet; however, the other commonly consumed vegetables can compensate for the minute nutrient loss, if any, from the sprouts of irradiated seeds.

Table 2. Nutrient Content of Cooked Mung Bean Sprouts and Some Commonly Consumed Vegetables*.

Vitamins/cup**	Carbohydrateg	Proteing	VitAiu	VitCmg	B1mg	B2mg	Niacinmg
Mung bean sprout/125g	7	4	30	8	0.11	0.13	0.9
Broccoli,boiled/155g	7	5	3,880	140	0.14	0.31	1.2
Cabbage/145g	6	2	190	48	0.06	0.06	0.4

*from Nutrition:Concepts and Controversies (E. Hamilton & E. Whitney edited, 1979)
** Serving size:1/2 cup

In summary, FDA reviewed information and references submitted in this petition, as well as other information in its files, to determine whether sprouts from irradiated alfalfa and other seeds would have an adverse effect on the nutritional value of the total human diet. Based on the exposure estimate, the nutrient content of the sprouts, and the changes in protein, carbohydrate and vitamins levels in the sprouts due to irradiation of seeds , we believe that the health impact of irradiated seeds will be minimal to nonexistent (see Table 2).

Conclusion

We have reviewed the data and information submitted in the petition (FAP 9M4673 and FAP 9M4651) and also considered all the available data and studies in our files relevant to assessing the toxicological and nutritional effects of irradiated foods. All the available data and information support the proposition that a toxicological hazard due to consumption of sprouts from irradiated alfalfa and other seeds is highly unlikely. Based on the dietary exposure estimates of the sprouts, and the nutrient content in the sprouts and other vegetables, consumption of sprouts from alfalfa and other seeds irradiated at a range of 1 to 8 kGy dose levels do not present either a toxicological or a nutritional concern.

Isabel S. Chen

Isabel S. Chen, Ph.D.

Attachments
INIT:A.Mattia A. Mattia
cc:HFS-200, HFS-207(Hansen, Mattia), HFS-225 (Edwards),
HFS-207:ISChen202-418-3036:Doc:IR9M4673

Attachment 1.

Table 1. Published Literature Submitted.

Authors	Title	Results and Comments
Daghir,N.J. et al.1983	Effect of gamma irradiation on nutritional value of lentils for chicks	Solubility of Lentils protein was reduced by Irradiation but did not change the crude protein of lentils.
Diehl,J.F. 1995	Radiological and toxicological safety of irradiated foods from Safety of Irradiated Foods	Discuss the history& progression of the safety studies on irradiated food.
Diehl,J.F. 1995	Nutritional adequacy of irradiated foods from Safety of Irradiated Foods	Irradiation dose of 30 kGy had no effect on biological availability of the macronutrients.
Eggum,B.O. 1979	Effect of radiation treatment on protein quality and vitamin content of animal feeds	Not relevant to nutrition or safety evaluation of sprouts.
Farkas,K. et al. 1973	Feasibility of irradiation of spices with special reference to paprika	Microbiological study no comment.
Fox,J.B. et al.	Effect of gamma irradiation on the B vitamins of pork chops & chicken breasts	Nutrient analysis of B vitamins in pork & chicken.
Hara-Kudo et al.	Potential hazard of radish sprouts as a vehicle of *Escerichia coli* 0175:H7	Microbiological information, no comment.
ICGFI*	Facts about food irradiation	General information of food irradiation.

Jaquette, C.B 1996	Efficacy of chlorine and heat treatment in killing *Salmonella stanley* inoculated onto alfalfa seeds & growth &survival of the pathogen during sprouting and storage	Not relevant to toxicological safety evaluation.
Kaferstein F.K. 1997	Food irradiation: The position of WHO	1997 WHO press release.
Kylen,A.M. et al. 1975	Nutrients in seeds and sprouts of alfalfa, lentils, mung beans and soy beans	Nutrient analyses of these seeds and sprouts.
Metta,V.C. et al. 1957	The effect of radiation sterilization on the nutritive value of foods	No significant loss in nitrogen content of the irradiation peas or beans. Irradiation sterilization did not affect the digestibility of the raw pea protein.
Moran,T. et al. 1968	Effect of Cobalt-60 gamma-irradiation on the utilization of energy, protein, and phosphorus from wheat bran by the chicken	Not relevant to nutrition or safety evaluation of sprouts.
O'Mahony, et al.1990	An outbreak of *Salmonella saint-paul* Infection associated with bean sprouts	Not relevant to toxicological safety evaluation.
Swallow, A.J. 1991	Wholesomeness and safety of irradiated foods from Nutritional & Toxicological Consequences of Food Processing (Friedmman ed.)	Precautions should be taken, if irradiation process is properly carried out on appropriate foods, irradiated foods are wholesome and safe.
Thayer D.W.	Wholesomeness of irradiated foods: A review	This review article concluded that if proper process 1994 conditions were taken, no adverse effects were noted in the irradiated foods.
Thorne S. 1991	Food irradiation	Food irradiation can extend the shelf-life of many foods, destruction of micro-organism.

Tipple, K.H.et al 1965	Some effects of high levels of gamma irradiation on the lipids of wheat	The gamma-irradiation effects on the lipids fraction depend on the level of dose, sprout content only about 0.2% of lipid.
Tobback P.P. 1977	Radiation chemistry of vitamins	The stability of vitamins in the irradiated foodstuffs is depends upon the nature and the composition of the food system.
Vaca, C.E. et al. 1986	Radiation-induced lipid peroxidation in whole grain of rye, wheat and rice: Effects on linoleic and linolenic	Lipid peroxidation increased with irradiation dose level but not relevant to sprouts (0.2% fat).
WHO 1994	Safety and nutritional adequacy of irradiated food	Most studies from FDA database.

*ICGFI International consultative group on food irradiation

DEPARTMENT OF HEALTH HUMAN SERVICES
FOOD AND DRUG ADMINISTRATION

Public Health Service

Memorandum

Date February 23, 2000

AD

From Division of Product Manufacture and Use, HFS-245

Subject FAP 9M4673: Use of Irradiation to Control Microbial Pathogens in Alfalfa and Other Sprouting Seeds

To Regulatory Policy Branch, HFS-206
Division of Product Policy
Attn.: JoAnn Ziyad, Ph.D.

INTRODUCTION

The Caudill Seed Co., Inc. is petitioning to amend 21 CFR 179.26 to include the use of ionizing radiation to control microbial pathogens in alfalfa and other sprouting seeds. The Caudill Seed Co., Inc. asserts that ionizing radiation is a safe and effective technology for the control of pathogenic organisms that may be present on seeds.

The sprouting of seeds for human consumption has become a common practice. Seed sprouting is a simple process that requires soaking of the dried viable seeds in water to allow germination and maintain high levels of moisture. Sprouts contain many substances that can serve as bacterial nutrients and they are grown in moist, warm conditions, that favor bacterial growth. Furthermore, it has been shown that the bacterial spores found in a variety of sprouts originated from seeds, rather than from other sources (e.g., water or equipment) in the environment of a typical commercial sprout production facility.[1] The petitioner asserts that irradiation treatment of alfalfa and other sprouting seeds can significantly reduce the microbial pathogens present on the seeds and, in some instances, eliminate them altogether.

In this memorandum, we present the results of our evaluation of the radiation chemistry of seeds under the proposed irradiation conditions, and the resulting effects on sprouts, the food which is actually consumed. We have used the data provided by the petitioner and information readily available in the literature, as well as information contained in the Division's files for our evaluation.

IDENTITY AND USE OF RADIATION SOURCE

The petitioner requests that the maximum absorbed dose for the irradiation of seeds be set at 8 kGy irrespective of the radiation source. The sources of ionizing radiation will be those listed under §179.26(a).[2]

EFFECTS OF IRRADIATION ON FOOD COMPONENTS

The effects of irradiation processing on the characteristics of the treated foods are a direct result of the chemical reactions induced by the absorbed radiation. The types and amounts of products generated by radiation-induced reactions (hereinafter referred to as "radiolysis products") depend on the chemical constituents of the food and on the conditions of irradiation. Scientists have compiled an enormous body of data regarding the effects of ionizing radiation on different foods under various conditions of irradiation.[3-7]

The major components of all foods are water, proteins, carbohydrates and lipids. The radiation chemistry of these components is well established. It has been shown that the amount of degradation of a food component by radiation is directly proportional to the radiation dose. It has also been shown that foods with high water content undergo more radiolysis-derived chemistry, due to the reactions associated with water radiolysis products, than do foods with relatively low water content. The radiolysis of water leads to the formation of reactive radicals capable of oxidizing or reducing other components of the irradiated food. When the water content is low, changes depend mainly on the direct effect of radiation (i.e., changes are induced by the direct, or primary, interaction of radiation with food components). But, when the water content increases, the relative concentration of the radiolysis products from secondary reactions of the reactive radicals from water radiolysis increases progressively.

The effect of water content on the irradiation properties of grains has been demonstrated.[8] It has been shown that for irradiated grain, the damage to the gluten is directly related to the water content of the grain.[8] Since seeds typically contain less than 10% water by weight, the chemical changes normally associated with the secondary reactions of water radiolysis products will be less than in foods with higher water content. A given radiation dose causes fewer chemical changes in dry plant material than in fresh fruits and vegetables.[6]

The seeds used for sprouting, per se, are not consumed. Only the sprouts that are formed due to the sprouting process are consumed. As the seeds mature and form sprouts, radiolysis products which may have been formed by irradiation of the seeds will be "diluted" in the final product. For example, alfalfa seeds contain only 7.4% water whereas alfalfa sprouts contain 88.3% water (see Table I). Also, it is likely that water-soluble products will be removed by the growth medium.

TABLE I. Nutrient Composition, per 100g of alfalfa seeds and raw sprouts.[9]

Sample	Water (%)	Protein (g)	Fat (g)	Fiber (g)	Carbohydrate (g)	Ash (g)
Seeds	7.4	35.1	12.6	7.9	41.8	3.1
Sprouts	88.3	5.1	0.6	1.7	5.6	0.4

The major nutritional components of the seeds - carbohydrate and protein - will be most affected by the direct interaction with the radiation. However, most of the carbohydrate is lost during maturation, and the protein concentration is also greatly reduced (see Table I). Likewise, the concentrations of the radiolysis products derived from the carbohydrate and protein will also be greatly reduced from their concentrations in the irradiated seeds. Only the sprouts, not the seeds are intended for consumption.

A. Effects on Macro constituents

The radiation chemistry of proteins has been extensively studied, and was reviewed in depth in previous reviews of poultry[10] and meat.[11] Although irradiation does not significantly alter the chemical composition of proteins,[12] changes are observed in their secondary and tertiary structures. These changes are similar to those that occur as a result of heating. When proteins are irradiated, several types of reactions can occur. One type of reaction leads to the breaking of a small number of peptide bonds to form polypeptides of shorter length than the original protein. Radiation damage can also lead to aggregation or cross linking of individual polypeptide chains which will result in protein denaturation. These changes are similar to those that occur as a result of heating. A third type of reaction that can occur involves the reaction of amino acids in the polypeptide chain with the free radicals from water, without the breaking of peptide bonds. The compounds produced by these reactions are similar or identical to those found in foods that have not been irradiated. Various studies have established that there is little change in the amino acid composition of proteins in foods irradiated at doses below 50 kGy.[13]

The radiation chemistry of carbohydrates has been mainly studied by investigating the radiation chemistry of monosaccharides, disaccharides or polysaccharides. The radiolysis of these simple carbohydrates demonstrates that irradiated starch degrades to dextrins, maltose, and glucose, leading to a decrease in the viscosity of solutions of polysaccharides. Carbohydrates present as a food component are much less prone to degradation than when irradiated in their pure form. The radiolysis of several varieties of starch (i.e., maize, wheat and potato) has been investigated.[14] The nature of the radiolysis products was found to be essentially the same regardless of the starch used. Increased amounts of sugar acids and ketones, oligosaccharides yielding monosaccharides, and polysaccharides yielding smaller units were reported. Generally speaking, the amount of water present in a carbohydrate-containing food markedly influences the nature and yield of the products formed.

The radiation chemistry of lipids is also well established.[15-16] Numerous studies have been performed with various oils and fats and also on the lipid fractions of irradiated foods. A variety of radiolysis products derived from irradiated lipids have been identified. Most of the radiolysis products are either the same as, or structurally similar to, compounds found in foods that have not been irradiated. These data have previously been reviewed by the FDA during its review of the radiation chemistry of meats.[11]

The chemical changes associated with the radiolysis of cereal grains,[8] beans,[17] and spices,[18] commodities which are similar to that of the seeds used for sprouting, have been reported in the

literature. The radiolysis products formed as a result of the irradiation of the lipid components of some of these foods were determined. The determination of these lipid-derived radiolysis products was difficult due to their low concentrations in the irradiated foods. For irradiated beans, the range for the radiolysis-derived hydrocarbons was 2 to 19 μg of products per g of fat (2-19 ppm of products in the fat) irradiated at 10 kGy, depending on the hydrocarbon analyzed and the bean studied. For irradiated spices, the values ranged from not detected (minimum quantifiable amount = 0.3 ppm) to 60 ppm in lipids at 5 kGy, depending on the hydrocarbon analyzed and the spice. Many of the products that were monitored were also found in products which were not irradiated, or were masked as a result of limitations of the analytical procedure. The low concentrations of these lipid-derived products for these commodities are expected since all of these commodities, except some beans, have very low concentrations of the lipid precursors.

In a recent report on irradiated sesame seeds (containing 48.6% fat) which were analyzed for radiolytically-derived hydrocarbons,[19] an absorbed dose of 0.5 kGy yielded approximately 0.2 µg of the hydrocarbon per g of oil and at 10 kGy a range of 0.2 to 8 µg of the hydrocarbon per g of oil, depending on the hydrocarbon, was observed. The amount of the hydrocarbons increased linearly with the dose. In contrast to sesame seeds, seeds for sprouting have a relatively low concentration of lipid (12.6% for alfalfa seeds). Therefore, the concentrations of the lipid-derived radiolysis products for the seeds listed in the petition will be lower than those observed for sesame seeds.

B. Effects on Micronutrients

Several vitamins are present in seeds and sprouted seeds (i.e., thiamin, riboflavin, niacin, pantothenic acid, vitamin B6, vitamin A and Ascorbic Acid).[9,20] No significant losses of any of the vitamins in the sprouts grown from irradiated seeds (up to 6 kGy) were noted when compared to nonirradiated controls (Laboratory 1. Woodson-Tenent Laboratories Inc. FAP9M4651 p35 by reference to FAP9M4673, Laboratory2. Greatlakes Scientific Inc. FAP9M4651 p35 by reference to FAP9M4673). There was a greater variability between the two laboratories than between the sprouts grown from control and irradiated seeds within the same study. As an example, the Vitamin A content of sprouts grown from control seeds was actually lower than that for sprouts grown from irradiated seeds (Laboratory 1: 146 IU/100g for control vs. 217 IU/100g for irradiated, Laboratory 2: 342 IU/100g for control vs. 429 IU/100g for irradiated).

CONCLUSION

We have reviewed the relevant data and information submitted in the petition, as well as data readily available in the literature and data available in our files, regarding radiation chemistry as it may apply to seeds. We conclude that the concentrations and types of radiolysis products formed by the irradiation treatment of seeds will be similar to that for other irradiated foods. In addition, we conclude that most of these radiolysis products are either the same as, or structurally similar to, compounds found in foods that have not been irradiated. The maximum absorbed dose proposed for the irradiation of seeds by the petitioner (8 kGy), will result in only minimal

changes in the macro constituents (protein, lipid or carbohydrate) of the seeds. The FDA came to the same conclusion in its review of the irradiation treatment of spices and concluded that the irradiation of spices with a dose of up to 30 kGy is safe (21 CFR 179.26).

By extension, the chemical composition of sprouts grown from irradiated seeds will not differ in any significant manner from sprouts grown from seeds which have not been irradiated.

We have no questions on the chemistry-related issues associated with this petition.

Kim M. Morehouse, Ph.D.

HFS-245 (Diachenko, Perfetti, files); 246 (Kuznesof, reading files); 226 (Hatton); 205; 206
HFS-245:KMMorehouse:205-4754:kmm 9-14-99, 11-16-99, 12-16-99, 02-08-00, 02-18-00
RD Init: PAHansen 10-28-99, 12-13-99 Init:PMKuznesof:02-18-00

(KMM:9M4673ch.wpd)

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2. These sources include γ-rays from sealed sources of ^{60}Co or ^{137}Cs, machine sources of accelerated electrons of energy up to 10 MeV, and machine-generated X-rays of energy up to 5 MeV.

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4. Wholesomeness of Irradiated Food, World Health Organization, Geneva, 1981.

5. Safety and Nutritional Adequacy of Irradiated Food, World Health Organization, Geneva, 1994.

6. J.F. Diehl, "Safety of Irradiated Foods" 2nd Edition, Marcel Dekker, Inc., New York, NY, 1995.

7. High-Dose Irradiation: Wholesomeness of Food Irradiated with Doses Above 10 kGy, World Health Organization, Geneva, 1999.

8. Lorenz, K. "Irradiation of Cereal Grains and Cereal Grain Products." Critical Reviews in Food Science and Nutrition, 6(4), 317-382, 1975.

9. Kylen, A.M. and McCready, R.M. "Nutrients in Seeds and Sprouts of Alfalfa, Lentils, Mung Beans and Soybeans." J. Food Science, 40, 1008-1009, 1975

10. Final rule for FAP 7M3974, Irradiation in the Production, Processing, and Handling of Food, Federal Register, Vol. 51, No. 75, pp. 13376-13399, April 18, 1986.

11. Final rule for FAP 4M4428, Irradiation in the Production, Processing, and Handling of Food, Federal Register, Vol. 62, No. 232, pp. 64107-64121, December 3, 1997.

12. See, J.F. Diehl, "Safety of Irradiated Foods" 2nd Edition, pp 63-72, Marcel Dekker, Inc., New York, NY, 1995.

13. Josephson, E.S., "Nutritional Aspects of Food Irradiaiton: An Overview." J. Food Processing and Preservation, 2, 299-313, 1979.

14. See, J.F. Diehl, "Safety of Irradiated Foods" 2nd Edition, pp 58-63, Marcel Dekker, Inc., New York, NY, 1995.

15. Nawar, W.W. "Reaction Mechansims in the Radiolysis of Fats: A Review." J Agric. Food Chem., 26, 21-25, 1978.

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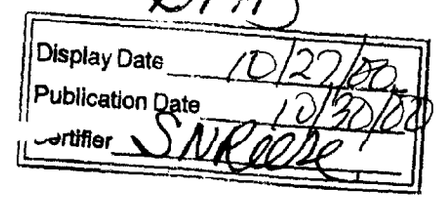
20. Composition of Foods, Agriculture Handbook No. 8-1, USDA, ARS (1976), (as ammended 1989), or, USDA Nutrient Data Base for Standard Reference, Release 12 (www.nal.usda.gov/fnic/foodcomp).

SMB



DEPARTMENT OF HEALTH AND HUMAN SERVICES

Food and Drug Administration

10/30/00
65 FR 64605

21 CFR Part 179

[Docket No. 99F–2673]

Irradiation in the Production, Processing and Handling of Food

AGENCY: Food and Drug Administration, HHS.

ACTION: Final rule.

SUMMARY: The Food and Drug Administration (FDA) is amending the food additive regulations to provide for the safe use of ionizing radiation to control microbial pathogens in seeds for sprouting. This action is in response to a petition filed by Caudill Seed Co., Inc.

DATES: This regulation is effective [*insert date of publication in the* **Federal Register**]. Submit written objections and requests for a hearing by [*insert date 30 days after date of publication in the* **Federal Register**]. 11/29/00

ADDRESSES: Submit written objections to the Dockets Management Branch (HFA–305), Food and Drug Administration, 5630 Fishers Lane, rm. 1061, Rockville, MD 20852.

FOR FURTHER INFORMATION CONTACT: Lane A. Highbarger, Center for Food Safety and Applied Nutrition (HFS–206), Food and Drug Administration, 200 C St. SW., Washington, DC 20204, 202–418–3032.

SUPPLEMENTARY INFORMATION:

I. Background

In a notice published in the **Federal Register** of August 16, 1999 (64 FR 44530), FDA announced that a food additive petition (FAP 9M4673) had been filed by Caudill Seed Co., Inc., 1402 West Main St., Louisville, KY 40203. The petitioner proposed that the food additive

NFR 1

regulations in part 179 *Irradiation in the Production, Processing and Handling of Food* (21 CFR part 179) be amended to provide for the safe use of sources of ionizing radiation to control microbial pathogens in alfalfa and other sprouting seeds.

II. Safety Evaluation

Under section 201(s) of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 321(s)), a source of radiation used to treat food is defined as a food additive. The additive is not, literally, added to food. Instead, a source of radiation is used to process or treat food such that, analogous to other food processes, its use can affect the characteristics of the food. In the subject petition, the intended technical effect is a change in the microbial load of the food, specifically, a reduction in the number of microbial pathogens in or on seeds for sprouting.

The petitioner submitted published articles and other study reports containing data and information related to seeds for sprouting and other kinds of food in the areas of radiation chemistry, nutrition, toxicology, and microbiology. FDA has fully considered the data and studies submitted in the petition as well as other information in its files relevant to the safety and nutritional adequacy of seeds treated with ionizing radiation prior to sprouting.

The effects of ionizing radiation on the characteristics of treated foods are a direct result of the chemical reactions induced by the absorbed radiation. Scientists have compiled a large body of data regarding the effects of ionizing radiation on different foods under various conditions of irradiation. Research has established that the types and amounts of products generated by radiation-induced chemical reactions (''radiolysis products'') depend on the chemical constituents of the food and on the conditions of irradiation. Furthermore, the principles of radiation chemistry govern the extent of changes, if any, both in the nutrient levels and in the microbial load of irradiated foods. Key factors include the specific nutrient or microorganism of interest, the food, and the conditions of irradiation. See the agency's final rule permitting the irradiation of meat for FDA's discussion of radiation chemistry, nutrition, toxicology, and microbiology related to irradiation of foods under various conditions of use (62 FR 64107, December 3, 1997).

FDA has reviewed the relevant data and information submitted in the petition regarding radiation chemistry as it applies to seeds for sprouting, as well as data readily available and in the agency's files. FDA has concluded that the concentrations and types of radiolysis products formed by the irradiation of seeds for sprouting will be comparable to those products produced by the irradiation of foods of similar composition (Ref. 1). Most of these radiolysis products are formed in very small amounts and are either the same as, or structurally similar to, compounds found in foods that have not been irradiated. Thus, the chemical composition of sprouts grown from irradiated seeds will not differ in any significant manner from sprouts grown from seeds that have not been irradiated.

This petition contained no toxicity studies on the sprouts grown from irradiated seeds. Nonetheless, a review of the agency's data base and submitted published references of toxicological studies related to irradiated foods, combined with the fact that only negligible amounts of radiolysis products are expected to be present in the sprouts that are grown from irradiated seeds for sprouting, show that the estimated exposure of an individual to these radiolytic products will be negligible. Therefore, FDA has determined that no toxicity concerns are raised from the petitioned use of irradiation on seeds for sprouting (Ref. 2).

The purported technical effect of irradiating seeds for sprouting is to control the level of microbial pathogens. FDA evaluated data on the relation between various doses of radiation and the reduction of detectable levels of coliforms generally, and *Escherichia coli* 0157:H7 and *Salmonella* serotype Stanley specifically. The petitioner found that, depending on the pathogen and other factors, between 3 and 5 KiloGray (kGy) of irradiation would reduce the amount of pathogens to below detectable levels (Ref. 3). To accommodate the uncertainty of irradiation treatment and dose variation due to absorption by the target, the petitioner requested a maximum irradiation dose of 8 kGy. The agency has determined that irradiation of seeds for sprouting at levels up to 8 kGy will have the desired effect of controlling the levels of microbial pathogens on seeds for sprouting (Ref. 3).

Regarding the nutritional aspects of irradiating seeds for sprouting, it is well documented that protein, fat, and minerals are not significantly altered by irradiation within the given dose range requested in this petition (Ref. 2). The petitioner evaluated the potential loss of vitamins from irradiation of seeds for sprouting. Although there was a great deal of variability in vitamin levels of the seeds tested (e.g., in studies submitted by the petitioner, vitamin A content of sprouts grown from control seeds was actually lower than that for sprouts grown from irradiated seeds), researchers did not observe any significant losses of any of the vitamins in the resultant sprouts (up to 6 kGy) when compared to nonirradiated controls. Any loss of vitamins, even if it occurs, is expected to be inconsequential when compared to total dietary nutrient consumption (Ref. 2). FDA therefore concludes, based on all the evidence before it, that irradiation of seeds for sprouting under the conditions set forth in the regulation below will not have an adverse impact on the nutritional adequacy of a person's diet.

III. Labeling

FDA has also considered whether irradiated seeds for sprouting and sprouts grown from such seeds must bear special labeling. In particular, FDA evaluated the application of § 179.26(c) (21 CFR 179.26(c)) to these products.

A. Seeds for Sprouting

Since any permissible use of ionizing radiation on seeds for sprouting must be in conformance with § 179.26(b), the label and labeling of such seeds for sprouting must comply with the requirements in § 179.26(c).

B. Sprouts Grown From Irradiated Seeds for Sprouting

It is important to recognize that in the use of radiation that is the subject of this rule, the irradiated article is not what is generally eaten because the unsprouted seeds are not normally consumed. While irradiation of the seeds for sprouting may cause some changes in the seed (for example, reduced viability of sprouting), the nutritional and flavor characteristics of the sprouts

will derive from the fact that they were grown and not from the fact that the seeds were processed by irradiation. Moreover, the agency has no reason to believe that sprouts grown from irradiated seeds will differ in their sensory characteristics from sprouts grown from seeds that have not been irradiated. Therefore, the agency concludes that sprouts grown from seeds that have been irradiated need not be labeled as treated by irradiation where the sprouts themselves have not been irradiated.

Based on the data and studies submitted in the petition and other information in the agency's files, FDA concludes that: (1) The proposed use of irradiation on seeds for sprouting at levels not to exceed 8 kGy is safe, (2) the irradiation will achieve its intended technical effect, and therefore, (3) the regulations in § 179.26 should be amended as set forth below.

In accordance with § 171.1(h) (21 CFR 171.1(h)), the petition and the documents that FDA considered and relied upon in reaching its decision to approve the petition are available for inspection at the Center for Food Safety and Applied Nutrition by appointment with the information contact person listed above. As provided in § 171.1(h), the agency will delete from the documents any materials that are not available for public disclosure before making the documents available for inspection.

This final rule contains no collections of information. Therefore, clearance by the Office of Management and Budget under the Paperwork Reduction Act of 1995 is not required.

IV. Environmental Impact

The agency has determined under 21 CFR 25.32(j) that this action is of a type that does not individually or cumulatively have a significant effect on the human environment. Therefore, neither an environmental assessment nor an environmental impact statement is required.

V. Objections

Any person who will be adversely affected by this regulation may at any time file with the Dockets Management Branch (address above) written objections by [*insert date 30 days after date of publication in the* **Federal Register**]. Each objection shall be separately numbered, and each

numbered objection shall specify with particularity the provisions of the regulation to which objection is made and the grounds for the objection. Each numbered objection on which a hearing is requested shall specifically so state. Failure to request a hearing for any particular objection shall constitute a waiver of the right to a hearing on that objection. Each numbered objection for which a hearing is requested shall include a detailed description and analysis of the specific factual information intended to be presented in support of the objection in the event that a hearing is held. Failure to include such a description and analysis for any particular objection shall constitute a waiver of the right to a hearing on the objection. Three copies of all documents shall be submitted and shall be identified with the docket number found in brackets in the heading of this document. Any objections received in response to the regulation may be seen in the Dockets Management Branch between 9 a.m. and 4 p.m., Monday through Friday.

VI. References

The following references have been placed on display at the Dockets Management Branch (address above) and may be seen by interested persons between 9 a.m. and 4 p.m., Monday through Friday.

1. FDA Memorandum, K. Morehouse to J. Ziyad, February 23, 2000.

2. FDA Memorandum, I. Chen to J. Ziyad, February 28, 2000.

3. FDA Memorandum, M. Walderhaug to J. Ziyad, December 15, 1999.

List of Subjects in 21 CFR Part 179

Food additives, Food labeling, Food packaging, Radiation protection, Reporting and recordkeeping requirements, Signs and symbols.

Therefore, under the Federal Food, Drug, and Cosmetic Act and under authority delegated to the Commissioner of Food and Drugs, and redelegated to the Director, Center for Food Safety and Applied Nutrition, 21 CFR part 179 is amended as follows:

PART 179—IRRADIATION IN THE PRODUCTION, PROCESSING AND HANDLING OF FOOD

1. The authority citation for 21 CFR part 179 continues to read as follows:

Authority: 21 U.S.C. 321, 342, 343, 348, 373, 374.

2. Section 179.26 is amended in the table in paragraph (b) by adding entry "10." under the headings "Use" and "Limitations" to read as follows:

§ 179.26 Ionizing radiation for the treatment of food.

* * * * *

(b) * * *

Use	Limitations
. . . .	. . .
10. For control of microbial pathogens on seeds for sprouting.	Not to exceed 8.0 kGy.

* * * * *

Dated: 10/20/00
October 20, 2000

L. Robert Lake,
Director of Regulations and Policy,
Center for Food Safety and Applied Nutrition.

[FR Doc. 00–???? Filed ??–??–00; 8:45 am]

BILLING CODE 4160–01–F